

## CHAPTER I INTRODUCTION

### A. Background

An increasing world population with new developments in technology and economy increases the demand in resources such as food and other living essentials. These developments result in an increase in the amount of waste that is being produced. USEPA defines solid waste as any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material, resulting from industrial, commercial, mining, and agricultural operations and from community activities (USEPA, 2013). In the city Surakarta, often called Solo the growing economy is also noticeable. This is a city in Central Java, Indonesia with a total population around 588.110 people (in 2011) with an average density of 13.354 people/km<sup>2</sup>. According to the Department of Sanitation in Surakarta (*Dinas Kebersihan Pertanaman*) the waste generation in Surakarta has been estimated at around 250 tons/day.

In many countries problems arises in the management of municipal solid waste. Increase in volume of waste generated, the change in the quality of waste composition and the treatment and disposal method of waste collected are of major concern. Municipal solid waste must be managed carefully so that environmental pollution can be avoided and human health will not be affected. One of the biggest problems in the management of Surakarta is that due to a high population density there is a difficulty in providing enough space for solid waste facilities, mentioned further in this research as TPS (*Tempat Pembuangan Sementara*/Temporary disposal) and some people resist that such a facility should be near their homes. An uneven distribution of the TPS and with no regard in the design of the TPS, the aesthetic environment gets effected that in turn effects the public health, reduces the beauty of the city and even creates bad traffic. The final processing place, mentioned further in this research as TPA (*Tempat Pemrosesan Akhir*/ Last Dumping Place) Putri Cempo is 17 acres big. This TPA has been active since 1985 and has a technical lifespan of 20 years and should have stopped in the year 2005. TPA Putri Cempo is already overloaded, because of the narrowness of the land and in turn building a sanitary landfill has been very difficult. People are less disciplined in putting the trash in its place

and the waste pickers at the TPS pay less attention to the aspect of neatness (DKP, 2014). Other municipalities around the world also have identified disposal of MSW as a major problem which needs urgent workable solutions. There is no one strategy that is suitable to apply for waste management. EPA developed a hierarchy ranking the most environmentally sound strategies for municipal solid waste. In this hierarchy, the 3R's Reduce, Reuse and Recycle are seen as the most preferred strategy in MSW management (USEPA, 2013). Both recycling and composting can decrease the use of natural resources, the amount of pollution in the atmosphere, and the amount of waste which would end up in landfills/dumping places.

The world is dependent on fossil fuels that include petroleum, natural gas and coal for our daily needs. Fossil fuels are created by the decomposition of dead plant and animal life that existed in the Earth millions of years ago. The amount of non-renewable energy resources is rapidly decreasing while the demand for more energy is increasing. The need to rely on alternative sources of energy such as solar, wind and hydro power to meet our daily needs increases. In the last decade adopting new renewable energy resources have increased although it will take a lot more years to decrease the dependency of the use of fossil fuels. Turning MSW into a renewable energy source can be a beneficial solution for both decreasing the amount of waste and for creating a new energy source.

Biomass can be converted into bio-fuel through different thermal, biological and physical processes. Among the biomass to energy conversion processes, pyrolysis has attracted more interest in producing liquid fuel product because of its advantages in storage, transport and versatility in application such as combustion engines, boilers turbines (Jahirul, 2012). Pyrolysis is a process wherein biomass are exposed to thermal treatment in the absence of an oxidizing agent, resulting in a solid (char), liquid (tar and bio-oil), and volatile gases ( $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{CH}_4$ , and  $\text{H}_2$ ). Studies have been done on the conversion of biomass into energy. Biomass is any type of organic material that is available on a renewable or reoccurring basis, and includes such things as agricultural crops and waste, wood and wood wastes, animal wastes, aquatic plants, and organic fractions of municipal and industrial waste (Shaw, 2006). Depending on the operating condition, pyrolysis can be classified into three main categories: conventional, fast and flash pyrolysis. These differ in

process temperature, heating rate, solid residence time, biomass particle size, *etc.* (Jahirul, 2012). Combustion of biomass or waste in combination with a base fuel is a simple and economically way to replace fossil fuels by biomass and to utilize waste. The burning characteristics of biomass may vary considerably depending on the composition of the raw material used (C. Rhen et al., 2007).

The kinetics of the In this research the global kinetics of combustion of municipal solid waste (MSW) is being studied to have a better understanding of the thermal degradation of MSW. Segregated MSW that has no economic value yet on the market is used in this research and have been collected from the TPA. The original condition of the selected samples of waste is that it already has been mixed with other MSW. The composition of the segregated MSW can be divided into two main groups: organic and inorganic MSW.

## **B. Problem statement**

Combustion characteristics are influenced by different factors. In this research the composition and the final pyrolysis temperature will be varied in order to identify the influences on the global kinetics. The problem statement in this research can be formulated into two questions:

1. How do the variations of the composition of waste influence the global kinetics on combustion of segregated MSW?
2. How do the variations of the final pyrolysis temperature influence the global kinetics on combustion of segregated MSW?

## **C. Purpose of this research**

The main purpose of this research is to know the characteristics of the combustion of MSW by analyzing the influence of the variations on composition and final pyrolysis temperature on global kinetics of combustion of segregated MSW.

#### **D. Benefits of this research**

The first beneficiary is the author who has the greater opportunity to develop a solid knowledge related to global kinetics of combustion of waste in the field of alternative energy, and punctually improve her capability and self-confidence to elaborate. Furthermore the results that can be implemented for further advanced studies.

The results of this study also has the potential to provide a start point for government institutions and other relevant stakeholders in order to maximize their role in developing new waste management technologies to create new energy resources from waste.

For the local communities especially those who are directly involved with waste handling, it will increase their awareness about the importance of waste as a resource for bio fuel, and the need for conservation from waste pollutant sources, where they can enhance their production and income leading to welfare and sustainable development.

The results can be applied in an up-scale mechanical reactor in any country.

#### **E. Significance of the research**

The amount of waste is increasing rapidly while many municipalities around the world are facing many environmental issues concerning waste management. Turning municipal solid waste into an alternative energy resource is one of the methods to reduce the amount of waste that brings many environmental and waste management concerns.

This research is an initial step that can have many possibilities in developing waste management technologies for alternative energy from waste. With the proper knowledge of global kinetics of combustion of MSW, it would be possible to select the correct composition of raw materials of waste that gives useful and desired burning characteristics. This is a necessary requirement in designing or optimizing pyrolysis or combustion reactors in the future.